**Citation:**

Byrd-Bredbenner C, Maurer J, Wheatley V, Cottone E, Clancy M. Food safety hazards lurk in the kitchens of young adults. *J Food Prot.* 2007 Apr; 70 (4): 991-996.

**PubMed ID:** 17477272

**Study Design:**

Cross-sectional study

**Class:**

D - Click here for explanation of classification scheme.

**Research Design and Implementation Rating:**

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

**Research Purpose:**

- To audit the kitchens of young adults with education beyond high school to identify food safety problems
- To develop recommendations for food safety education efforts for this consumer group.

**Inclusion Criteria:**

Young adults attending a major northeastern university:

- 18 to 26 years old
- Lived in a single-family-type dwelling (e.g., apartment, house) with a readily accessible kitchen
- Did not hold sanitation certification
- Were in good or excellent health
- Not at increased risk of food-borne disease (e.g., did not have weakened immune systems, were not pregnant or lactating)
- Lived within 25 miles (40km) of campus
- If vegan, reported that they cooked fish, poultry, meat, eggs and dairy.

**Exclusion Criteria:**

Excluded, if not included above.

**Description of Study Protocol:**

**Recruitment**

- Via official university student e-mail listserves and advertisements placed in the campus

newspaper
- Interested participants completed a brief online screening questionnaire which was reviewed by a trained researcher to identify those meeting eligibility requirements (as described above).

**Design**

- Home kitchen observations to assess the following compared with recommended practices:
    - Compliance of home food storage and rotation practices
    - Time, temperature, sanitation and chemical storage practices
    - General kitchen condition (e.g., pest infestation, maintenance, plumbing)
- After the home audit, participants completed an online survey that collected demographic data
- Instrument for home kitchen observations:
    - Used by Audits International in an exploratory study of food safety in home kitchens served as a guide for development
    - Based on food service facility inspection techniques typically used in restaurants
    - Utilized an objective critical control point approach and standards elucidated in the model food code from the US Food and Drug Administration adapted for home evaluation
    - Reviewed for completeness, accuracy and appropriateness by a licensed sanitarian and a registered environmental health specialist
    - Pilot tested in home kitchens and refined
    - Final version contained seven scales
    - Compliance with each recommended practice earned one point
        - Scores for all scales, except for Cold Food Storage, ranged from zero to the maximum number of items on the scale. Cold Food Storage scores could range from zero to 10
        - All items within a scale were weighted equally
        - To adjust for items that did not apply to certain participants, a scale score was computed by summing the points earned for each applicable item, dividing this sum by the number of items that applied to the participant, and multiplying the result by 10
- Refrigerator and freezer temperatures were measured with a thermocouple
- Auditors were trained to conduct the home kitchen observations.

**Statistical Analysis**

- Statistical analyses were completed by Statview
- Fifteen (10%) of the 154 home kitchen audits were randomly double-coded independently by two trained auditors (Inter-rater reliability of 0.95)
- Descriptive statistics:
    - Means and standard deviations to describe the study population
    - Frequencies used to evaluate key home kitchen observations
    - Mean scores for each home kitchen observation instrument scale
        - Calculated for the population as a whole
        - Stratified by gender
    - Comparisons between genders
        - Student’s T-tests
        - Mann-Whitney U-test for rank-order variables.

**Data Collection Summary:**

**Timing of Measurements**

Home audit followed by online survey.

**Dependent Variables**

Final version of home audit instrument contained seven scales:

- Kitchen Cleanliness (eight items)
- Appliance Cleanliness (three items)
- Cleaning Supplies Availability (eight items)
- Temperatures (Food Thermometer Access and Refrigerator and Freezer Temperatures) (five items)
- Cold Food Storage (seven items)
- Dry Food Storage (eight items)
- Poisons Storage (two items) (see Table 1 for items in each scale).

**Independent Variables**

Demographic data collected after the home audit through an online survey.

**Description of Actual Data Sample:**

- *Initial N:*
  - 1,228 individuals completed the brief online screener questionnaire
  - 432 (35%) met the criteria for participation as described above and were invited via e-mail to sign up for scheduled study participation time
- *Attrition (final N):*
  - Primary reason for ineligibility: Lack of access to kitchen in their home
  - 167 individuals accepted the invitation and scheduled a time to begin the study
  - 154 honored their appointment time and completed the home kitchen audit between April and October 2005
- *Age:* Mean age was 20.7±1.3 SD (range, 18 to 26) years
- *Ethnicity:* Most were white
- *Other relevant demographics:*
  - From wide array of college majors, with no major predominating
  - 99% prepared one or more meals every week
  - Most were:
    - Female
    - Never married
    - Juniors or seniors
  - Most participants:
    - Did not believe they or a household member had experienced food poisoning in the past year
    - Had never held a job serving or preparing food
    - Had never completed a college course in nutrition, food science or microbiology
    - Self-rated their food safety knowledge level and food safety skill (food poisoning prevention) level as at least fair
- *Location:* Not specified; participants were from a major northeastern university.

**Summary of Results:**

**Key Findings**

Most participants:

- Did not believe they or a household member had experienced food poisoning in the past year
- Had never held a job serving or preparing food
- Had never completed a college course in nutrition, food science, or microbiology
- Self-rated their food safety knowledge level and food safety skill (food poisoning prevention) level as at least fair.

Home kitchen observation:

- Participants scored 70% or higher on following scales:
  - Poisons Storage
  - Dry Food Storage
  - Kitchen Cleanliness
  - Cleaning Supplies Availability
- Participants scored less than 60% on:
  - Appliance Cleanliness
  - Cold Food Storage scales
- Performance was lowest on the Temperatures scale
- Females scored significantly higher than males on the Kitchen Cleanliness and Cleaning Supplies Availability scales
- Average refrigerator and freezer temperatures exceeded recommendations
- Mean refrigerator temperature was 6.1±3.6$^{o}$C SD; range, 0 to 16$^{o}$C
- Frequencies of key home kitchen audit observations:
  - 80% had cutting boards
  - 92% had soap available near the sink
  - 83% had paper towels available near the sink
  - 62% had paper towels available near the sink
  - 62% had clean sponges
  - 7% had a food thermometer.

**Other Findings**

- Three of the seven items on the Cold Food Storage scale were not applicable in some cases (e.g., participant did not have any eggs or raw animal flesh stored in the refrigerator)
- Each home kitchen audit took approximately 20 minutes to complete.

**Author Conclusion:**

- Overall, the home kitchens of young adults appeared to be clean to sight and touch with adequate stores of kitchen cleaning supplies available, but nearly half had dirty kitchen appliances
- Packaged dry goods appeared to be wholesome and safe to consume
- Dry food storage met guidelines for preventing pest infestation, contamination from poisonous materials and dampness from sink drains. Conversely, home kitchens were found to have problems that could be potentially hazardous

- Temperature regulation was a major food safety problem, as mean refrigerator temperatures were higher than recommended. Only 7% of home kitchens had access to food thermometers. Freezer temperatures were low enough to keep foods safe, but not as low as recommended to maintain food quality. Access to food thermometers was very limited, precluding ability to respond to current food safety educational messages promoting the use of thermometers to check doneness
- The unsanitary condition of kitchen appliances and lack of adequate temperature regulation in the home kitchens support need to emphasize maintaining foods at safe temperatures thorough cooking to recommended internal temperatures, storing food in cold-enough temperatures, and avoiding cross-contamination by keeping food contact surfaces clean.

***Reviewer Comments:***

- *Refrigerator and freezer temperatures are not available for all participants*
- *Authors note: Due to fiscal and logistical reasons, the study was limited to a single institution of higher learning, but the institution had a demographically diverse student body, likely representative of other student bodies in the US.*

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***Research Design and Implementation Criteria Checklist: Primary Research***

| **Relevance Questions** | | |
|---|---|---|
| 1. | Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies) | N/A |
| 2. | Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about? | Yes |
| 3. | Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice? | Yes |
| 4. | Is the intervention or procedure feasible? (NA for some epidemiological studies) | Yes |

| **Validity Questions** | | |
|---|---|---|
| **1.** | **Was the research question clearly stated?** | Yes |
| 1.1. | Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified? | Yes |
| 1.2. | Was (were) the outcome(s) [dependent variable(s)] clearly indicated? | Yes |
| 1.3. | Were the target population and setting specified? | Yes |
| **2.** | **Was the selection of study subjects/patients free from bias?** | Yes |

| | | |
|---|---|---|
| 2.1. | Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study? | Yes |
| 2.2. | Were criteria applied equally to all study groups? | Yes |
| 2.3. | Were health, demographics, and other characteristics of subjects described? | Yes |
| 2.4. | Were the subjects/patients a representative sample of the relevant population? | Yes |
| **3.** | **Were study groups comparable?** | N/A |
| 3.1. | Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT) | N/A |
| 3.2. | Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline? | N/A |
| 3.3. | Were concurrent controls used? (Concurrent preferred over historical controls.) | N/A |
| 3.4. | If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis? | N/A |
| 3.5. | If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.) | N/A |
| 3.6. | If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")? | N/A |
| **4.** | **Was method of handling withdrawals described?** | N/A |
| 4.1. | Were follow-up methods described and the same for all groups? | N/A |
| 4.2. | Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.) | N/A |
| 4.3. | Were all enrolled subjects/patients (in the original sample) accounted for? | N/A |
| 4.4. | Were reasons for withdrawals similar across groups? | N/A |
| 4.5. | If diagnostic test, was decision to perform reference test not dependent on results of test under study? | N/A |
| **5.** | **Was blinding used to prevent introduction of bias?** | N/A |

| | | |
|---|---|---|
| 5.1. | In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate? | N/A |
| 5.2. | Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.) | N/A |
| 5.3. | In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded? | N/A |
| 5.4. | In case control study, was case definition explicit and case ascertainment not influenced by exposure status? | N/A |
| 5.5. | In diagnostic study, were test results blinded to patient history and other test results? | N/A |
| **6.** | **Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?** | Yes |
| 6.1. | In RCT or other intervention trial, were protocols described for all regimens studied? | N/A |
| 6.2. | In observational study, were interventions, study settings, and clinicians/provider described? | Yes |
| 6.3. | Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect? | N/A |
| 6.4. | Was the amount of exposure and, if relevant, subject/patient compliance measured? | N/A |
| 6.5. | Were co-interventions (e.g., ancillary treatments, other therapies) described? | N/A |
| 6.6. | Were extra or unplanned treatments described? | N/A |
| 6.7. | Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups? | N/A |
| 6.8. | In diagnostic study, were details of test administration and replication sufficient? | N/A |
| **7.** | **Were outcomes clearly defined and the measurements valid and reliable?** | Yes |
| 7.1. | Were primary and secondary endpoints described and relevant to the question? | Yes |
| 7.2. | Were nutrition measures appropriate to question and outcomes of concern? | Yes |
| 7.3. | Was the period of follow-up long enough for important outcome(s) to occur? | N/A |
| 7.4. | Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures? | Yes |
| 7.5. | Was the measurement of effect at an appropriate level of precision? | N/A |
| 7.6. | Were other factors accounted for (measured) that could affect outcomes? | Yes |

| | | |
|---|---|---|
| 7.7. | Were the measurements conducted consistently across groups? | Yes |
| **8.** | **Was the statistical analysis appropriate for the study design and type of outcome indicators?** | Yes |
| 8.1. | Were statistical analyses adequately described and the results reported appropriately? | Yes |
| 8.2. | Were correct statistical tests used and assumptions of test not violated? | Yes |
| 8.3. | Were statistics reported with levels of significance and/or confidence intervals? | Yes |
| 8.4. | Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)? | N/A |
| 8.5. | Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)? | N/A |
| 8.6. | Was clinical significance as well as statistical significance reported? | Yes |
| 8.7. | If negative findings, was a power calculation reported to address type 2 error? | N/A |
| **9.** | **Are conclusions supported by results with biases and limitations taken into consideration?** | Yes |
| 9.1. | Is there a discussion of findings? | Yes |
| 9.2. | Are biases and study limitations identified and discussed? | Yes |
| **10.** | **Is bias due to study's funding or sponsorship unlikely?** | Yes |
| 10.1. | Were sources of funding and investigators' affiliations described? | Yes |
| 10.2. | Was the study free from apparent conflict of interest? | Yes |